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GENETIC IMPROVEMENT OF EGG PRODUCTION FROM CROSSING TWO DEVELOPED STRAINS WITH A COMMERCIAL LAYING HENS

By

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Abstract: *Genetic analyses of experimental data of Mandarah and Silver Montazah strains and their crosses with commercial laying hens Lohman Brown (LB) were done to exploit the existing genetic variations for improving some egg production traits. It was obvious from this study that LB was superior than both developed strains for all the traits.The differences between parents were highly significant in all the studied traits. The studied traits showed highly significant differences between hybrids, hybrids vs. parents and 3-way crosses vs. single crosses. The effect of heterosis was weak and negative in single crosses when measured as a deviation from the commercial strain (LB). Moreover, negative heterosis revealed lower single crosses than mid-parents for the most of the studied traits, but positive heterotic effects were found for egg number at 240 (d.) and 52 wks of laying and egg mass till 52 wks of laying. As related to age at sexual maturity, positive heterosis revealed a later age at sexual maturity of the single crosses than both mid-parents and LB. The mean parents in general had some performance higher to those of their 3-way crosses, notably for body weight at sexual maturity and egg weights at 90, 240 d and 52 wks of production traits. The results of 3-way crosses obtained for age at sexual maturity, egg number at 90, 240 d, 52 wks of lying and egg mass at 52 wks of production showed superiority of 3-way crosses than both single crosses and LB. Both additive and dominance genetic components of variance play an important role in the inheritance of egg production traits. Since, the analysis revealed that the nature of gene effects were predominantly additive for the most of the studied traits while, egg number at the first 90 d of laying and egg weight at 52 wks of production were affected by dominance genetic components. The average degree of dominance ($\hat{h}$) was varied from partial dominance of the high parent for body weight at sexual maturity and egg weight at 240 d of laying to* *complete dominance of the low parent for sexual maturity, egg weight at the first 90 d., of laying, egg number till 52 wks of production and egg mass till 52 wks of production to over dominance of the low parents for egg number at 90 and 240 d of laying and egg weight at 52 wks of production. Additive x Additive type of epistasis was found to be much larger in magnitude than additive x dominance and dominance x dominance epistatic types for all the studied traits except for body weight at sexual maturity. The former results indicated that 3-way crosses could, consequently, allow higher genetic gains in the performance of their progenies and would be effective in improving most of the studied traits.*

INTRODUCTION

Crossing is widely used in breeding of chicken especially between local chicken and exotic standard strains. Local chickens appear to have an inherent scavenging habit and they have better survival than the commercial hybrid strains under local production conditions but they are poor egg producers. This is so different than commercial hybrids, with their poor immune systems, limited ranging and high food value demands. So their crossing usually retains superb genetic vigor and excellent adaptaion and health record. Generally, it is well known that the genetic improvement is a complex phenomenon and it could be contributed to the components of genetic variance. These genetic components of variance are especially needed when applying a combined crossbred and purebred selection method to achieve genetic progress in crossbreds (Wei and van der Werf, 1994). Thus, biometrical analyses were used to compare different genetic groups derived from crossing two developed strains of chickens with commercial laying hens (Lohman Brown) to assess and quantify the dominance, epistasis and additive genetic effects (Ketata *et al.*, 1976). Dominance effect is predicted to be large on some egg production traits (Fairfull and Gowe, 1990; Wei *et al.*, 1991 a,b; Wei and van der Werf, 1993; Abou El-Ghar *et al.*, 2003 and Abou El-Ghar and Abdou, 2004). While the magnitude of additive effect is much greater than dominance effect on some egg production traits (Redman and Shoffner 1961; Yao 1961; Wearden et al. 1965; Szydlowski and Szwaczkowski 2001 and Abou El-Ghar 2009). However, epistatic effects were detected as a major mechanism of heterosis. Bauman (1959) proposed that epistasis is indicated if the performance of the progeny of a cross between a single cross and a tester deviates significantly from the average performance of the single crosses produced by crossing two inbred lines. Crow and Kimura (1970) reported that physiological epistasis contributes to additive, dominance and interaction genetic values and variances. Evidence supporting epistasis as a major mechanism of heterosis in chickens (Sheridan and Randall, 1977; Sheridan,1980 and Fairfull *et al.*, 1985, 1987). The heterotic effects on egg production traits includes variability produced by both dominance and epistasis (Fairfull *et al.*, 1985,1987 and Abou El-Ghar and Abdou, 2004). The objective of this study was to achieve genetic improvement for egg production in crossbreds by applying a crossbred methods between two local developed strain of chickens and a commercial laying hens.

MATERIALS AND METHODS

The experimental data were collected at El-Sabahia Poultry Research Station, Animal Production Research Institute, Agriculture Research Center.

Experiment Design:

Two developed strains, Mandarah and Silver Montazah were crossed as a Sire lines with a commercial laying hens Lohman Brown as a Dam line to produce their Single Crosses; Mandarah x Lohman Brown (Mn x LB) and Silver Montazah x Lohman Brown (SM x LB). Then crossing these single crosses to produce 2 Three way crosses (Mn x SM x LB) and (SM x Mn x LB) crosses. All experiment families; Mandara, Silver Montazah, Lohman Brown, Single crosses and Three way crosses were ajusted into Randomized Compelete Block Design with five replicates. The observations were recorded on 545 hen pure lines, 110 hen single crosses and 110 hen 3-way crosses.

Management Conditions:

All management practices were similar as possible for all replicates throughout the experiment. Artificial insemination was applied by assigning 5 females per each male. Two hatches in each mating combination were used, for each hatch eggs were collected throughout 7 d and incubated in full-automatic draft machine. At hatch, all chicks were wing-banded and weighed to the nearest gram. The chicks were fed *ad libitum* a commercial starter ration (19 % CP and 2800 KCal) up to 8 weeks of age, then the ration was changed by commercial grower ration (15 % CP and 2700 KCal) up to 20 weeks of age. During the production period the pullets were fed a commercial layer ration (16.5 % CP and 2750 KCal) and They were housed in individual cages and received 16 hr day light. At the onset of lay eggs were recorded and weighted daily during the first 90 (d.) of production, then twice a week till the end of experiment.

The Studied Traits:

Nine egg production traits were studied; i.e. age at sexual maturity (ASM), body weight at sexual maturity (BW), number of eggs at 1st 90 d. of laying (EN1), average egg weight through the 1st 90 d. of laying (EW1), number of eggs at 240 d. of laying (EN2), egg weight at 240 d. of laying (EW2), number of eggs at 52 wks of laying (EN3), egg weight at 52 wks of laying (EW3) and egg mass throughout 52 wks of laying (EM).

Statistical Analysis:

The data derived from four crosses along with their parents were firstly analyzed in conventional analysis of variance to test the significance among the different genetic groups.

Heterosis percentages (H) based on both mid-parents (MP) and high-parent (HP) were determined according to equations given by (Sinha and Khanna, 1975) as follows:

$$H\ (MP)\ \% = \frac{F_1 - MP}{MP} \times 100$$

$$H\ (HP)\ \% = \frac{F_1 - HP}{HP} \times 100$$

Where: (H) % = heterosis percentage, F_1 = mean of crosses, MP = mid-parents, HP = high parent (Lohman Brown).

The procesdure followed for partitioning of variance into its components was done by using the method of (Ketata et. al., 1976). The analysis is based on the following model,

$$Xijk = M + Gij + rk + eijk$$

Where, ***Xijk*** denotes to the phenotypic value of the single cross between ***Li*** (commercial laying hens) and the developed strain ***J***, ***M*** denotes to the mean of all single and three way crosses, ***Gij*** denotes to the genotypic value of the cross between ***Li*** (commercial laying hens) and the developed strain ***J***, ***rk*** denotss to the effect of replication ***k*** and ***eijk*** denotes to the error associated with the cross ***ij*** in replication ***k***.

The total genetic variance was partitioned into: $\sigma^2 A$ = additive genetic variance, $\sigma^2 d$ = dominance genetic variance, $\sigma^2 i$ = additive x additive epistatic variance, $\sigma^2 j+l$ = additive x dominance and dominance x dominance epistatic variance.

The degree of dominance ($\hat{h}$) was estimated according to equations given by (Griffing, 1950). $(\hat{h}) = (\sigma^2 d / \sigma^2 A)^{0.5}$

$\sigma^2 A$ = additive mean square, $\sigma^2 d$ = dominance mean square.

RESULTS AND DISCUSSION

Means:

Generally, the commercial strain LB was superior to both Mandarah and Silver Montazah strains in means of all the studied traits as showen in Table (1). Where, it has 158 d for age at sexual maturity (ASM), 1751 g for body weight at sexual maturity (BW), 58 egg for egg number at the first 90 d of laying (EN1), 59 g for egg weight at the first 90 d of laying (EW1), 157 egg for egg number at 240 d of laying (EN2), 62 g for egg weight at 240 d of laying (EW2), 202 egg for egg number at 52 wks of laying (EN3), 63 g for egg weight at 52 wks of laying (EW3) and 12.9 kg for egg mass at 52 wks. of laying (EM). It could be concluded that LB mostly contains genes having both additive and non-additive positive effects for these traits that were not present in Mandarah and Silver Montazah strains. This finding dealt with that cited by Sheridan (1986). On the other hand, the single cross Mandrah x LB was superior to the other single cross Silver Montazah x LB for ASM (188vs 189 d.), BW (1610 vs 1581g.), and EN1 (41vs 36 egg), while the opposite situations were found for EW1 (52.2 g.), EN2 (154 egg), EW2 (55 g.), EN3 (210 egg) and EM (11.8 kg). In general the results of parental strains and single crosses showed that single crosses had better means of ASM, BW, EW1, EN2, EW2, EN3, EW3 and EM compared with mid of Mandarah and Silver Montazah parents (188 d., 1595 g., 51 g., 142 egg, 54.5 g., 195 egg, 56 g., and 10.9 kg. vs. 189 d., 1518 g., 47.4 g., 123 egg, 51.9 g., 145 egg, 53.3 g., and 7.7 kg., respectively). Although, the single crosses means of the studied traits were lower than the commercial strain (LB) means in this regard. These results mean that dominance tended to the higher parent (LB) of the previous traits. Contrarly, the mean of single crosses for EN1 (38 egg) was lower than both mid- parents of Mandarah with Silver Montazah and the commercial strain LB (44 and 58 egg). This means that dominance towards low parents (Mandarah and Silver Montazah strains) was observed for this trait.

Moreover, means of 3-way cross Silver Montazah x Mandrah x LB for ASM, EN1, EN2, EN3 and EM were better than the other 3-way cross Mandarah x Silver Montazah x LB (156 d., 73 egg, 181 egg, 240 egg and 13.9 kg. vs. 159 d., 64 egg, 168 egg, 226 egg and 12.9 kg., respectively). The contrasts are shown for BW, EW1, EW2 and EW3, respectively. Also, the 3-way crosses showed the highest performance of their means for ASM (158 d.), EN1 (68 egg), EW1 (52.1 g.), EN2 (175 egg), EW2 (56.3 g.), EN3 (233 egg), EW3 (57 g.) and EM (13.3 kg.), when combared with the single crosses means and for all the studied traits when combared with the corresponding estimates of Mandarah and Silver Montazah means. Moreover, the 3-way crosses means were exceeded the commercial strain LB in EN1, EN2, EN3 and EM traits but they had the same age at sexual maturity. The results of egg production traits were in agreemrnt with those reported by (El-Housari *et al.*, 1992; Nawar and Bahei El-Deen, 2000; Iraqi *et al.*, 2007 and Iraqi, 2008). These results showed clearly that the trait EM which is a combination of two traits egg number and egg weight, and it was mainly affected by the first one. Moreover, epistatic effects may control the inheritance of egg number and egg mass traits. These observations are needed when applying a combined crossbred and purebred selection method to achieve genetic progress for egg production in crossbreds. The same conclusion was cited by Wei and van der Werf (1994).

***Variances*:**

Regarding the variations among the different genetic groups, it is evident from (Table 2) that all egg production traits studied were statistically differ significantly (P<0.01) among replicates and among genotypes. The same trend was found among parents, between hybrids and within LB. It also appears from Table 2 that the interaction effect of hybrids vs. parents, single crosses vs. Mandrah & Silver Montazah, single crosses vs. LB, 3-way crosses vs. Parents, 3-way crosses vs. Mandrah & Silver Montazah, 3-way crosses vs. LB and 3-way crosses vs. single crosses were highly significant for all of the studied traits. The insignificant estimates of differences among genetic groups for ASM traits were found in between Mandarah and Silver Montazah strains, between single crosses and between 3-way crosses, also their estimates of variance for EW3 were insignificantly different. In addition, the variations for EW1 in between Mandarah and Silver Montazah strains. The estimates of variation for BW were rather insignificant in between single crosses. These findings of variation for egg production traits support the previous estimates of means of the different genetic groups.

***Heterosis*:**

The degrees of heterosis on the bases of mid-parents and high Parent (commercial strain LB) were presented in Table 3. It was notcied that the trait ASM had positive heterotic effects when assumed as a difference between single crosses mean and the means of mid-parents and high Parent (5.4 and 19.3 %,-respectively). This means that dominance tended to the higher parent of this trait. On the other hand, the traits EN2, EN3 and EM had positive heterosis percentages on the base of mid-parents 6.0, 19.0 and 15.4, respectively, but on the base of high parent they showed negative heterosis percentages (-10.0, -3.0 and -15.3, respectively). Therefore, it could be concluded that dominance toward the lower parent was found in these traits. These results agreed with the finding reported by Fairfull *et al.* (1983) who reported that the crosses of the better parental lines can be expected to maintain the average superiority of their parents. The remaining traits (i.e. BW, EN1, EW1, EW2 and EW3) showed negative heterotic effects on the bases of both mid-parent and high parent, this means that dominance for low parent was found for these traits. Otherwise, the estimates of heterosis for single crosses showed that the single cross Silver Montazah x Mandarah (SM x Mn) had better estimates of heterosis percentages than the reciprocal cross Mandarah x Silver montazah (MN x SM) for EW1, EN2, EW2, EN3 and EM traits, while the contrasts were found for ASM, BW, EN1 and EW3 traits.

Also it could be seen from Table 3 that the 3- way crosses mean was beter than both single crosses and high parent for ASM, EN1, EN2, EN3 and EM traits and the estimates of heterosis percentages on the base of mid-parents (single crosses & LB) were -11.5, 53, 19, 18 and 14.7, respectively. These estimates were -0.1, 19, 17, 15 and 3.1 % on the base of high parent (LB). This means that dominance toward the better parent LB was found for these traits and their inheritance may be affected by non-additive effects especially over-dominance and/or epistatic effects. The same conclusion was observed by (Jinks and Jones, 1958; Cheverud and Routman, 1995 and Fairfull *et al.*, 1985, 1987). On the other hand, the traits BW, EW1, EW2 and EW3 had negative heterosis percentages -6.1, -3.3, -1.5 and -2.6 on the base of mid-parents, respectively.These traits showed the same negative directions of heterosis on the base of high parent LB (-11.6, -12.5, -10.0 and -10.3, respectively). Which means that dominance for low parent (single crosses) was found for these traits. Further discussion of the results of heterosis percentages in Table 3, the 3-way cross (SM x Mn x LB) was superior to the other 3-way cross (Mn x SM x LB) in heterosis percentages for ASM, EN1, EN2, EN3 and EM traits, while (Mn x SM x LB) was superior for BW, EW1, EW2 and EW3 traits. Such results may fitt the hypothesis that using Silver montazah as a sire parent and Mandarah as a dam parent would benefit for some egg production traits. The same findings agreed with those reported by Fairfull (1990); Boutrous (1998); Nawar and Abdou (1999); Nawar and Bahie El-Deen (2000); Iraqi *et al.*, (2007) and Iraqi (2008).

Genetic Variance Components:

The components of genetic variance presented in Table 4, reflected that additive genetic component σ^2A was positively higher estimated than dominance component σ^2d for ASM, BW, EW1, EN2, EN3 and EM (3.12, 0.013, 2.9, 19.9, 7.3, 239 and 0.381 vs. -1.55, 0.004, -3.2, -385.9, 2.2, -595 and -0.971, respectively). These results indicated that additive components may be detected in the inheritance of these traits. Same conclusion was reported by Redman and Shoffner (1961); Yao (1961); Wearden *et al.* (1965); Szydlowski and Szwaczkowski (2001) and Abou El-Ghar (2009). Furthermore, two of the studied traits showed higher estimates of σ^2d 81.8 and 1.3 for EN1 and EW3, respectively. The corresponding additive mean squares (σ^2A) were -3.5 and -0.105, respectively. Therefore, the inheritance of these traits may be affected by non-additive effects especially over-dominance. The same conclusion was reached by Jinks and Jones (1958) who reported that over-dominance may be responsible for heterosis, when the dominance components were greater than the additive components of variation.

Further analysies fit the presence of over dominance effects on EN1 and EW3 traits that the ratio of the mean square of dominance to the additive mean square ($\hat{h}$) were estimated to be -4.8 and -1.6, respectively. Such results suggested that over-dominance of the low parent was controlling the inheritance of EN1 and EW3 in the single crosses. On the other hand, partial dominance of the high parent was important for both BW and EW2 traits, their $\hat{h}$ values were 0.57 and 0.6, respectively. While partial dominance of the low parent was found for ASM it's $\hat{h}$ value was -0.71. Also complete dominance was present in the inheritance of EW1 and EM and over-dominance was controlling the inheritance of EN2 and EN3 their $\hat{h}$ estimates being -1.05, -1.1, -4.4 and -1.6, respectively.

Regarding the 3-way crosses results, it could be concluded that epistasis effects were controlling the inheritance of the studied traits. Cheverud and Routman (1995) reported that some epistatic effects were confounded within the measurement of additive effects. It was noticed from Table 4, that the estimated additive x additive epistatic components of genetic variance ($\sigma^2 i$) seem to be highly significant positive for all the studied traits except for BW which had insignificant variation of additive x additive type of epistasis. In addition the insignificant negative estimates of additive x dominance and dominance x dominance types of epistatic mean square ($\sigma^2 j+l$) suggestes that non-allelic interaction was the major source of variations in egg production traits and additive x additive type of epistasis may be responsible for heterosis in 3-way crosses. These results were confirmed with findings of (Sheridan and Randall, 1977; Sheridan,1980; Fairfull *et al.*, 1985, 1987 and Abou El-Ghar and Abdou, 2004).

CONCLUSION

Generally, the former results showed clearly that annual egg yield by kg., (EM) was largely affected by the rate of lay (EN), such traits were genetically controlled by both additive effect and additive x additive type of non-allelic interaction. Moreover, the 3-way crosses achieved superiority of egg number and egg mass means than both single crosses and the commercial strain . So, these observations are needed to select the best crossbred method, which achieves the most higher genetic progress for egg production in crossbreds. The present findings suggestes that the 3-way crosses would be effective in improving annual egg production yield.

Table (1): Means and sd of some egg production traits from crossing two developed strains with Lohman Brown

Genotype	Traits								
	ASM	BW	EN1	EW1	EN2	EW2	EN3	EW3	EM
Parents									
LB	158±12.4	1751±164	58±12.3	59.6±3.7	157±25	62.5±4.3	202±36	63.5±3.9	12.9±2.7
Mn	189±14.3	1489±166	40±12.2	47.4±2.6	117±19	51.6±1.4	135±22	53.1±2.6	7.2±1.2
SM	190±8.6	1547±175	48±11.3	47.4±3.5	129±22	52.2±1.9	155±25	53.5±1.5	8.3±1.3
Mean	178±19.3	1601±203	49±14.0	51.7±6.7	135±28	55.7±5.9	165±40	57.0±5.7	9.6±3.1
Single Crosses									
MnxLB	188±1.8	1610±177	41±11.2	49.9±3.1	130±13	54.0±1.6	179±27	56.0±1.2	10.0±1.6
SMxLB	189±2.5	1581±174	36±11.2	52.2±2.7	154±8	55.0±0.8	210±25	55.9±1.1	11.8±1.4
Mean	188±2.2	1595±175	38±11.5	51.0±3.1	142±16	54.5±1.4	195±30	56.0±1.1	10.9±1.7
3-way Crosses									
MnxSMxLB	159±7.9	1586±150	64±8.8	53.4±3.7	168±10	57.0±1.6	226±15	57.1±1.2	12.9±0.9
SMxMnxLB	156±4.8	1509±155	73±8.9	50.8±3.9	181±9	55.5±2.3	240±17	56.8±2.2	13.9±1.1
Mean	158±6.7	1547±157	68±9.8	52.1±4.0	175±11	56.3±2.1	233±17	57.0±1.8	13.3±1.1
Total Hybrids	173±16.1	1571±168	53±18.4	51.6±3.6	158±21	55.4±2.0	214±31	56.5±1.6	12.1±1.9

ASM = age at sexual maturity, BW = Body weight at sexual maturity, EN1 = Egg number at the 1st 90 d. of laying, EW1 = Egg weight at the 1st 90 d. of laying, EN2 = Egg number at 240 d. of laying, EW2 = Egg weight at 240 d. of laying, EN3 = Egg number at 52 wks. of laying, EW3 = Egg weight at 52 wks. of laying, EM = Egg mass at 52 wks. of laying, LB = the commercial laying hens Lohman Brown, Mn = Mandarah strain, SM = Silver Montazah strain, MnxLB = single cross Mandarah x Lohman Brown, SMxLB = single cross Silver Montazah x Lohman Brown, MnxSMxLB = 3-way Crosses Mandarah x Silver Montazah x Lohman Brown, SMxMnxLB = 3-way Crosses Silver Montazah x Mandarah x Lohman Brown.

Table (2) Mean squares of some egg production traits from crossing two developed strains with Lohman Brown

S.O.V	d.f	Traits								
		ASM	BW	EN1	EW1	EN2	EW2	EN3	EW3	EM
Bet. Rep.	4	3242**	0.133**	664**	436.7**	2917**	102.9**	6820**	66.1**	40.8**
Bet. Genotypes	4	48013**	2.841**	24615**	5060.2**	99132**	3858.5**	252475**	3613.9**	1284.2**
Error	765	77	0.022	111	7.4	281	5.1	563	4.5	2.4
Bet. Parents	2	**	**	**	**	**	**	**	**	**
Bet. Mn&SM	1	NS	**	**	NS	**	**	**	NS	**
Within LB	194	**	*	**	**	**	**	**	**	**
Bet. Hybrids	3	**	**	**	**	**	**	**	**	**
Bet. Single Crosses	1	NS	NS	**	**	**	*	NS	NS	**
Bet. 3-way Crosses	1	NS	**	**	**	**	**	**	NS	*
Hybr. vs. Parents	1	**	**	**	**	**	**	**	**	**
S.C vs. Mn &SM	1	**	**	**	**	**	**	**	**	**
S.C vs. LB	1	**	**	**	**	**	**	**	**	**
3-way vs. Parents	1	**	**	**	**	**	**	**	**	**
3-way vs. Mn &SM	1	**	**	**	**	**	**	**	**	**
3-way vs. LB	1	**	**	**	**	**	**	**	**	**
3-way vs. S.C	1	**	**	**	**	**	**	**	**	**

ASM = age at sexual maturity, BW = Body weight at sexual maturity, EN1 = Egg number at the 1st 90 d. of laying, EW1 = Egg weight at the 1st 90 d. of laying, EN2 = Egg number at 240 d. of laying, EW2 = Egg weight at 240 d. of laying, EN3 = Egg number at 52 wks. of laying, EW3 = Egg weight at 52 wks. of laying, EM = Egg mass at 52 wks. of laying, LB = the commercial laying hens Lohman Brown, Mn = Mandarah strain, SM = Silver Montazah strain, S.C = single 3-way = 3-way crosses. * = significant at 5 % level, ** =highly significant at 1% level, NS = insignificant

Table (3) Heterosis percentages from mid parent (MP) and high parent (HP) for some egg production traits

Crosses		Traits								
		ASM	BW	EN1	EW1	EN2	EW2	EN3	EW3	EM
Single Crosses	H%(MP)	5.4	-0.02	-21	-0.8	6	-17.0	19	-1.3	15.4
	H%(HP)	19.3	-8.9	-33	-14.3	-10	-12.9	-3	-11.9	-15.3
MnxLB	H%(MP)	8.5	-0.6	-16	-6.7	-5	-5.4	6	-3.9	0.2
	H%(HP)	19.2	-8.1	-29	-16.3	-17	-13.7	-11	-11.8	-21.9
SMxLB	H%(MP)	8.6	-4.1	-32	-2.4	8	-4.1	18	-4.5	11.1
	H%(HP)	19.4	-9.7	-38	-12.4	-2	-12.0	4	-12.0	-8.6
3-way Crosses	H%(MP)	-11.5	-6.1	53	-3.3	19	-1.5	18	-2.6	14.7
	H%(HP)	-0.1	-11.6	19	-12.5	17	-10.0	15	-10.3	3.1
MnxSMxLB	H%(MP)	-8.0	-5.6	30	-2.4	17	-2.1	19	-4.5	12.7
	H%(HP)	0.8	-9.4	12	-10.4	7	-8.8	12	-10.1	0.3
SMxMnxLB	H%(MP)	-9.7	-9.4	56	-9.1	17	-5.5	16	-4.9	10.6
	H%(HP)	-1.0	-13.8	26	-14.7	16	-11.2	19	-10.6	5.8

ASM = age at sexual maturity. BW = Body weight at sexual maturity. EN1 = Egg number at the 1st 90 d. of laying, EW1 = Egg weight at the 1st 90 d. of laying, EN2 = Egg number at 240 d. of laying, EW2 = Egg weight at 240 d. of laying, EN3 = Egg number at 52 wks. of laying, EW3 = Egg weight at 52 wks. of laying, EM = Egg mass at 52 wks. of laying, LB = the commercial laying hens Lohman Brown, Mn = Mandarah strain, SM = Silver Montazah strain, S.C = single 3-way = 3-way crosses, (MP) = mid parent, (HP)= high parent (LB), H% = Heterosis percentages

Table (4): Components of genetic variation for some egg production traits

Traits	Components of genetic variance				
	$\sigma^2 A$	$\sigma^2 d$	$\hat{h}$	$\sigma^2 i$	$\sigma^2 J+l$
ASM	3.12	-1.55	-0.71	412243 **	-18692 NS
BW	0.013	0.004	0.57	1.007 NS	-0.005 NS
EN1	-3.5	81.8	-4.8	397441**	-17926 NS
EW1	2.9	-3.2	-1.05	505**	-2.0 NS
EN2	19.9	-385.9	-4.4	479952**	-21640 NS
EW2	7.3	2.2	0.6	1440**	59.0 NS
EN3	239	-595	-1.6	638339**	-28522 NS
EW3	-0.105	1.3	-3.6	431.4**	-15.6 NS
EM	0.381	-0.971	-1.1	2447.8**	-109.6 NS

$\sigma^2 A$ = Additive genetic variance, $\sigma^2 d$ = Dominance genetic variance, $\hat{h}$ = the degree of dominance. $\sigma^2 i$ = Additive x Additive type of epistatic variance,
$\sigma^2 J+l$ = Additive x Dominance and Dominance x Dominance types of epistatic variance,
** = highly signigicant of variance, NS = insignificant of variance

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الملخص العربي

التحسين الوراثي لإنتاج البيض عند خلط سلالتين مستنبطتين مع سلالة تجارية من الدجاج البياض

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التحليلات الوراثية لبيانات الخلط بين سلالتى المندرة والمنتزه الفضي وسلالة تجارية من الدجاج البياض (لوهمان البنية) قد اجريت لإستخدام التباين الوراثي الموجود بالفعل بين تلك السلالات في تحسين صفات إنتاج البيض. ولقد كان واضحا من نتائج هذه التجربة ان السلالة التجارية قد تفوقت على كل من السلالتين المستنبطتين فى كل الصفات المدروسة. أن الإختلافات بين الآباء كانت عالية المعنوية في كل الصفات تحت الدراسة. أيضا ظهرت إختلافات عالية المعنوية فيما بين الخلطان وبين الآباء والخلطان وبين الخليط الثلاثي والهجن الفردية وعموما كان تأثير الخلط ضعيفا وسالبا وذلك في الهجن الفردية عندما قيس على كونه الفرق بين متوسط الهجن الفردية ومتوسط السلالة التجارية (لوهمان البنية). علاوة على أن قوة الهجين كانت سالبة بالنسبة لصفات عدد البيض عند اعمار ٢٤٠ يوم و ٥٢ أسبوع من بداية الإنتاج وصفة كتلة البيض عند عمر ٥٢ أسبوع من بداية الإنتاج. وفيما يتعلق بصفة العمر عند النضج الجنسي فإن قيمة قوة الهجين الموجبة تدل على تأخر الوصول الى النضج الجنسي فى الهجن الفردية عن متوسط الأباء وعنه فى حالة السلالة التجارية. وعموما لوحظ أن متوسط الأباء كان أعلى من مثيله في الهجن الثلاثية وذلك بالنسبة لصفات وزن الجسم عند النضج الجنسي ووزن البيضة عند أعمار ٩٠ و ٢٤٠ يوم و٥٢ أسبوع من بداية إنتاج البيض. بالنظر الى نتائج الهجن الثلاثية بالنسبة لصفات العمر عند النضج الجنسي وعدد البيض عند أعمار ٩٠ ، ٢٤٠ يوم و٥٢ أسبوع من بداية وضع البيض وكذا كتلة البيض عند عمر ٥٢ أسبوع من بداية الإنتاج نجد تفوقا للهجن الثلاثية عن مثيلاتها الهجن الفردية وعن السلالة التجارية (لوهمان البنية). ولقد ثبت أن كلا من التباين الوراثي التجميعي وتباين السيادة تلعب دورا مهما فى وراثة صفات إنتاج البيض فقد أظهرت النتائج أن طبيعة فعل الجين غالبا ماتكون تجميعية بالنسبة لمعظم الصفات المدروسة فى حين أن صفات عدد البيض خلال الـ ٩٠ يوم الأولى من إنتاج البيض ووزن البيضة عند عمر ٥٢ أسبوع من إنتاج البيض قد تأثرت بالتباين السيادي . ولقد إختلف متوسط درجة السيادة من سيادة جزئية للأب الأعلا وذلك فى صفات وزن الجسم عند النضج الجنسي ووزن البيضة عند عمر ٢٤٠ يوم من بداية وضع البيض الى سيادة تامة للأب الأقل وذلك فى صفات العمر عند النضج الجنسي ووزن البيضةعند عمر ٩٠ يوم الأولى من إنتاج البيض وعدد البيض عند عمر ٥٢ أسبوع من إنتاج البيض وكتلة البيض حتى عمر ٥٢ أسبوع من إنتاج البيض الى سيادة فائقة للأب الأقل فى صفات عدد البيض عند أعمار ٩٠ و ٢٤٠ يوم من بداية وضع البيض ووزن البيض عند عمر ٥٢ أسبوع من الإنتاج. ولقد وجد أن تأثير التفوق من نوع تجميعي x تجميعي اكبر وأكثر أهمية من الأنواع الأخرى للتفوق مثل تجميعي x سيادي و سيادي x سيادي وذلك بالنسبة لكل الصفات المدروسة عدا صفة وزن الجسم عند النضج الجنسي. وعموما فإن النتائج السابقة توضح أن الخلط الثلاثي قد يحقق قدراًكبيراً من التحسين الوراثي فى النسل الناتج من ذلك الخلط وربما تكون طريقة الهجن الثلاثية طريقة فعالة فى تحسين معظم الصفات المدروسة.